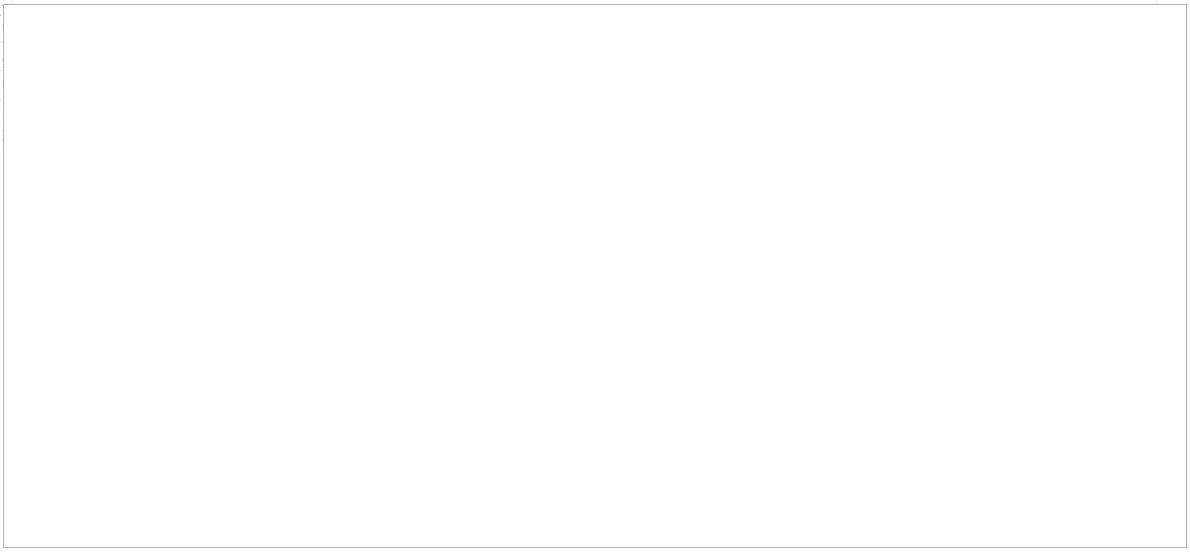

Title: SOVIET SCIENTIST A. S. POPOV

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A. S. POPOV

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A. S. Popov began his scientific activity while still a student in the Physico-Mathematical Faculty of St. Petersburg University (1877-1882). At that time, the world renowned scientists D. I. Mendeleyev, P. L. Chebyshev, and A. M. Butlerov were teaching at this university.

The head of the university physicists was Professor F. F. Petrushevskiy who was the first in Russia to introduce practical studies on physics for students. Sessions of the Physical Department of the Russian Physico-Chemical Society were held at that time in the University. V. V. Lermantov, from whom Popov learned the correct experimental and theoretical procedures, worked in the Physics Laboratory.

Popov became interested in electrical engineering and began to attend the sessions of the Russian Technical Society, which had just been organized. In this society, he became acquainted with well-known Russian electrical engineers such as P. N. Yablochkov, A. N. Ledygin, V. N. Chikolev, P. N. Bulygin, and N. A. Lachinov. Along with a number of other young physicists interested in electrical engineering, Popov was an [illegible] at the Electrical engineering exhibit (1881) and worked in the "Elektrotekhnik" Association, where he studied the equipping and exploitation of small electric power stations. In 1882, Popov wrote his thesis on "The Principles of Magneto- and Dynamoelectric Direct-Current Machines"

In 1883, Popov became an assistant on galvanism and head of the Physics Desk Cabinet of the Torpedo Officers' Class (Kronshtadt). Here A. S. first studied higher mathematics and then a course in applied physics and electrical engineering. Those who heard Popov's lectures say that he could state the essence of a topic in clear and simple terms. He gave particular attention to practical work and attached great importance to lecture demonstrations. His experiment with the slow rise of current in an inductive circuit became a classic. Called "Popov's experiment", it is still being shown today.

Soon Popov began to teach physics and electrical engineering at the Maritime Technical School. Spending all his free time in the laboratory, Popov himself wound coils, blew glass, and produced the instruments and models which he needed.

In 1883, he published his scientific work "Conditions for Most Efficient Operation of Dynamo-Electric Machines" in the periodical "Elektrichestvo". The clear and concise presentation of the problem and the simple solution employed testified to the ability of the young scientist. Popov's activity in this period took on so many different facets that, in the words of Professor N. N. Georgiyevskiy, who at one time worked with Popov, "there was not an important problem which somehow bordered on the fields of physics and particularly of electrical engineering, that was solved without the participation of A. S. Popov" His rapidly growing authority served as a basis for his being sent to an exhibit in Chicago "to inspect and study topics in electrical engineering".

A. S. diligently pursued whatever was new in the field of electrical engineering and immediately discerned those which might have potentialities. As soon as he found out about the discovery of X-rays, he himself produced an X-ray tube and established that the source of X-ray radiation was the fluorescing part of the tube. Popov was especially interested in effects caused by hf currents. He himself constructed a Tesla coil and a number of instruments for experiments with it. The report on Hertz's works on electromagnetic waves greatly interested Popov. He constructed the necessary instruments and studied all these effects thoroughly.

Shortly before this, there Branley's work had appeared on the property of metallic powders to change their conductivity under the action of electric oscillations. A tube filled with this powder and equipped with two electrodes was called a coherer.

But neither Hertz nor Branley, nor many other physicists who studied electromagnetic waves, could or would even attempt to bridge the gap from the pure laboratory studies of various partial problems to their broad generalizations and practical use. This major advance, which opened a new page in the history of mankind, was made by A. S. Popov, the great inventor of radio

Popov demonstrated the first radio receiver in the world at a meeting of the Russian Physico-Chemical Society on May 7, 1895. Popov modestly called his instrument a "storm detector" because at first his instrument received only the electrical disturbances caused by thunderstorm discharges due to the absence of sufficiently powerful sources of electric oscillations.

An antenna was used for the first time in this receiver; this was a copper wire one end of which was connected to the coherer, while the other electrode of the coherer was grounded. Popov connected a sensitive electromagnetic relay in series with the coherer in order to "amplify" the signals. In addition, a metal shield was used to prevent possible external disturbances.

Thus, even in his first receiving unit, Popov had such important elements as an antenna, relay (now an electronic tube), and a shield. Later, Popov made a substantial improvement by introducing tuning to the desired wavelength, using the phenomena of resonance.

The results obtained by Popov were described in the article "An Instrument for Detecting and Registering Electromagnetic Oscillations" (1896). He ended his article with the well-known words "In conclusion, I should like to express the hope that my instrument when further improved may be used for the transmission of signals over a distance with the help of rapid electric oscillations. As soon as a source of such oscillations having sufficient power is found". In this account, Popov's device is treated as one receiver or "storm-detector". However, in another paper, "The First Receivers of A. S. Popov" (Radio, No 5, 1951), G. V. Dobropistsev, a scientific worker in the Central M Communications Museum imeni A. S. Popov, describes two different instruments as follows: "Both the instruments mentioned above, the first radio receiver (April 1895) and the first storm detector (July 1895) are now held in the Central Communications Museum imeni A. S. Popov in Leningrad. We should emphasize that sometimes in our literature the "receiver" and "storm detector" concepts are confused, although these are two different instruments constructed by the inventor at different times".

began to experiment with transmitters. By using a vertical antenna, [illegible] a transmission range of 60 m and on March 24, 1896 at a session of the [illegible] Physical-Chemical Society, he with the help of his receiver accomplished for the first time in the world radio transmission of signals from one building to another. A Morse telegraph was connected to the receiver. Professor F. F. Petrushevsky who was presiding at the session, decoded the marks appearing on the tape and wrote them on the blackboard. Thus was sent the first radiogram in the world. In the early part of 1896, Popov had already accomplished radio transmission over a distance of 600 m (Kronstadt shore - ship). In 1896, P. N. Rybkin established that it was possible to receive radiotelegraph signals with a directional "by ear" with the help of a telephone; A. S. again improved his equipment and the range of communications increased to 50 km.

A report appeared soon afterwards which served as an impetus to the development of radiotelegraphy in Russia and helped to obtain wide acknowledgement of Popov's services. This was the breakdown of the battleship "General-admiral Apraksin", which ran aground at Gogland Island in December of 1899. The rescue work required rapid establishment of communications with Kronstadt, and the naval office decided to use the wireless telegraph. This first practical radio communications line in the world began operation on February 6, 1900 and operated for the several months the battleship remained aground.

Starting in 1896-1897, Popov repeatedly made reports and communications on "Telegraphy without wires" in which he analyzed the physics of the effects and gave information on the results he had obtained. In Popov's reports, articles, and official documents of this period there are many valuable statements on various problems of radio engineering. These still retain their importance at the present time.

For example, in the report of the Commission of the Main Naval Headquarters on experiments with radio communication on the Baltic in 1897, we find "The influence of the ship setting shows up in the following: all metal objects, e.g., masts, pipes, rigging, must interfere with the operation of the instruments both at the sending and receiving stations because they, being in the path of the electromagnetic waves, disturb their regularity partly in a way similar to [illegible] a breakwater acts upon an ordinary wave on the water sur-

face and partly due to the ~~inform~~ interference of waves set up in them with the waves of the source". Today we are constantly confronted with these effects, which indicate the possibility of devising directional antennas. They are important, for example, in clarifying problems connected with ~~d~~disturbances in the directional action of antennas located near extraneous conductors; they also determine the requirements imposed upon ~~selection of~~ the antenna site ~~spot for arranging antennas~~.

Popov's remarks on the influence of a ship crossing the line of communication upon radio communication between two ships are also of special interest today. He wrote "There was also observed an influence of a middle ship. Thus, during experiments between the "Yevropa" and the "Afrika", the cruiser "Leytenant Il'in" intervened, and if the distances were great enough, communication between the instruments on the first two ships stopped until the "Leytenant Il'in" departed from the line connecting the two ships". These historic observations (repeated in America only after 25 years had passed) were the basis from which radar was developed several decades later.

In the same report there were remarks indicating the feasibility of radio-navigation and radio difection finding: "The use of a source of electromagnetic waves in lighthouses in addition to the light or sound signal can make the lighthouses visible in fogs or in stormy weather; an instrument, detecting electromagnetic waves, can warn of the proximity of the lighthouse by a bell, while the interval between rings will make it possible to discriminate between lighthouses. The direction of the lighthouse can be determined by using the property of the mast and rigging to delay, ~~xxxxx~~ or shade, the electromagnetic waves". Interesting points on the radiation of a vertical antenna and the influence of the earth's surface are found in a report made by Popov at the First All-Union Electrical Engineering Conference (January 1900).

At this conference, Popov said the following in regard to the history of his invention: "In June (1897), there appeared a description of Marconi's instruments, after which he obtained a patent in England and several other countries. The instruments used in Marconi's experiments which made possible telegraphy at distances up to 12 km consist of the same components as the instrument which I have described....in any case, my combination of a relay, a tube, and a tapper

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and sounder (a small eletromagnetic hammer) served as the basis for Marconi's first patent ...".

With these restrained words, the great scientist modestly pointed out his indisputable priority in the discovery of radio and indicated that Marconi had dishonestly appropriated his idea and design.

In continuing to develop Soviet wireless telegraphy and participating actively in many experiments, Popov gave a great deal of attention to the training of radio specialists. He attached great importance to practical work both in the laboratory and in operating units. We have retained a program for a course in wireless telegraphy drawn up by Popov on 24 April 1900 which provided for 15 hours of lectures and 30 hours of practical work.

In 1901 Popov was appointed a professor of physics in the St. Petersburg Electrical Engineering Institute and began to give teaching in this institute much of his time. With surprising penetration Popov foresaw the important role of electrodynamics and the need for approaching the study of electrical engineering and radio engineering on this theoretical basis.

Although mainly occupied with his teaching activity in this period, Popov did not detach himself from practical problems. For example, when the Ministry of the Main Administration of Mails and Telegraph considering the possibility of establishing radio communications between Varna and Odessa, Popov on 4 March 1901 responded with a note in which he expressed his complete confidence in the possibility of establishing such communication. In this note, he pointed out that greater communications ranges are easier obtained on sea than on land. He correctly observed the difference in the propagation of radio waves over land and sea. From the engineering standpoint, he recommended the construction of the station in Sevastopol' instead of in Odessa. He also pointed out that listening in to the transmissions would be difficult because of the great distance of the Varna-Sevastopol' line from the Rumanian shores.

In the winter of 1901, A. S. submitted a report at a meeting of the Society of Natural Scientists and Physicians on the latest progress of wireless telegraphy and demonstrated tuning of a receiving conductor into resonance with a radiating vibrator. Still concerned with the study of resonance Popov on

October 3, 1895 submitted the report "Concerning Wavemeters, Serving for the Measurement of the Length of Electromagnetic Waves or For Determining the Period of Electric Oscillations". He demonstrated instruments and effects encountered in wireless telegraphy practice and emphasized their impertance for physicists working ink the field of electric oscillations.

The short but brilliant life of Aleksandr Stepanovich Popov ended on January 13, 1906, shortly after he was elected Director of the Electrical Engineering Institute. At this time, he also headed the progressive part of the professorate which was fighting the decrees of the Czarist government directed against the student body.

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